Understanding the Atmosphere of 51 Eri b: Do Photochemical Hazes Cloud the Planet's Spectrum?

M. Marley, K. Zahnle, J. Moses, C. Morley and the GPI Survey Team

The first young giant planet to be discovered by the Gemini Planet Imager was the ~ 2MJ planet 51 Eri b. This ~20 Myr old young Jupiter is the first directly imaged planet to show unmistakable methane in H band. To constrain the planet's mass, atmospheric temperature, and composition, the GPI J and H band spectra as well as some limited photometric points were compared to the predictions of substellar atmosphere models. The best fitting models reported in the discovery paper (Macintosh et al. 2015) relied upon a combination of clear and cloudy atmospheric columns to reproduce the data. However for an object as cool as 700 K, the origin of the cloud coverage is somewhat puzzling, as the global silicate and iron clouds would be expected to have sunk well below the photosphere by this effective temperature. While strong vertical mixing in these low gravity atmospheres remains a plausible explanation, we have explored whether atmospheric photochemistry, driven by the UV flux from the primary star, may yield hazes that also influence the observed spectrum of the planet. To explore this possibility we have modeled the atmospheric photochemistry of 51 Eri b using two state-of-the-art photochemical models, both capable of predicting yields of complex hydrocarbons under various atmospheric conditions. In our presentation we will summarize the modeling approach employed to characterize 51 Eri b, explaining constraints on the planet's effective temperature, gravity, and atmospheric composition and also present results of our studies of atmospheric photochemistry. We will discuss whether photochemical hazes could indeed be responsible for the particulate opacity that apparently sculpts the spectrum of the planet.